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ABSTRACT

The paper describes the application of discriminant analysis to the identification of academically gifted elementary grade students. The principles of discriminant analysis are explained to provide a weighted profile of scores across predictor variables which are then compared with a criterion measure. An illustration of the method's used with 64 possibly gifted students in Garden City, Kansas, is given. The screening procedure focused on three predictor variables: student standardized achievement test scores, teacher ratings, and student performance and response rates on a series of nonverbal tasks. Additionally, 85 experts in gifted education were asked to indicate the prevalence of specific behaviors in gifted and nongifted children and the relative importance of each characteristic. Experts rated cognitive factors as the best predictors of giftedness. Teachers identified four factors as most predictive of giftedness: creativity, diligence, high level cognition, and criticism of self and others. Among nonverbal tasks found to be predictive were the Maze Tracing Speed Test, the Identical Pictures Test, Addition/Subtraction Test, Story Sequence Test, and Number Comparison Test. A score of 125 or higher on the Wechsler Intelligence Scale for Children-Revised was used as the criterion measure to classify students into gifted and nongifted groups. Use of the method to identify students for individualized testing would have led to a 26% reduction in individual testing time while being 90% accurate in the identification of gifted students. (DB)

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USE OF DISCRIMINANT ANALYSIS IN THE IDENTIFICATION OF GIFTED STUDENTS

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Use of Discriminant Analysis in the Identification of Gifted Students

The purpose of the present paper is to primarily provide an illustration of the use of discriminant analysis as part of an initial screening process for the identification of academically gifted students in Project IMPAC. Prior to the illustration, a brief presentation of discriminant analysis is provided. It should be noted that the presentation that follows on discriminant analysis has been simplified to provide a general awareness of the technique. For detailed discussions of discriminant analysis and classification procedures, the following may be referenced (Huberty, 1975; Lindeman, Merenda & Gold, 1980; Overall and Klett, 1972; Tatsuoka, 1971).

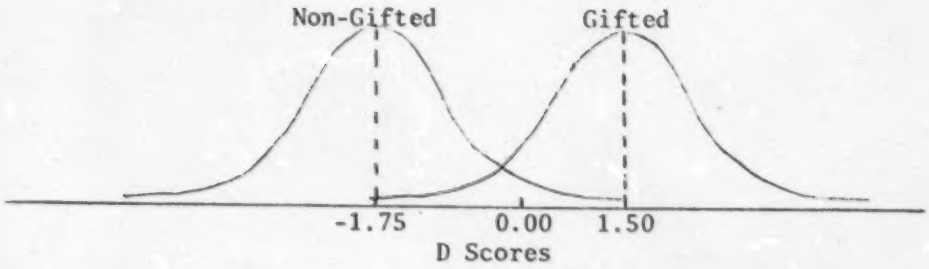
Discriminant analysis is a multivariate statistical technique which combines information contained in several predictor variables to maximize prediction of group membership for a given set of data. The approach is very similar to the use of multiple regression techniques where several predictor variables are combined to maximize prediction of scores on some continuous criterion variable. However, in discriminant analysis, the criterion to be predicted is not a continuous variable. Rather, it is a nominal level variable where classification into groups is the only measurement characteristic. The method of discriminant analysis results in the reduction of several predictor variables to one or more weighted combinations which maximize the differentiation among members of the different groups.

To be more concrete, the differentiation between gifted and non-gifted students is a natural example for the application of discriminant analysis. The criterion variable to be predicted is the degree of giftedness measured as a dichotomous, group membership variable, gifted and non-gifted. In an identification process, one would want to find variables which are predictive of which group an individual belongs. Possible predictor variables are teacher ratings, parent ratings, peer ratings and achievement test scores. The question is, "Which of these variables is predictive of whether a child is gifted or non-gifted?" Rephrased in discriminant analysis terminology, "What is the weighted profile of scores across these variables which will maximally separate these two groups, thus allowing for maximum prediction of group membership with minimum error?" The application of discriminant analysis resulted in a weighted linear composite of the predictor variables. The variables will be assigned weight of a given magnitude dependent on their importance to the prediction relative to the other variables. For example, if X_1 = teacher rating score, X_2 = parent rating score, X_3 = peer rating score and X_4 = a composite achievement score, then the general form of the discriminant analysis equation would be:

$$b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 = D$$

where b_1, b_2, b_3 and b_4 are the weights assigned to each variable and D is the discriminant score. The analysis results in determining the value of the weights which result in discriminant scores, D, that maximally discriminate between the two groups, i.e., the majority of gifted students would get high D scores and the non-gifted students would get primarily low D scores.

For prediction and classification purposes, the D scores are plotted for each group and a cut score is determined which will minimize the overlap in the two sets of scores. For example the two distributions might look like the following.



As can be seen the two distributions overlap. The question becomes, what D score does one choose as the cut-off score for defining which group an individual belongs.

The process of discriminant analysis requires that group membership be determined using come criterion to initially get the discriminant equation. An individually administered IQ test might serve as the ultimate criterion for defining gifted and non-gifted students. This test would initially be administered to all students and data would be collected on the predictor variables. This data would then be used to derive the weights for the predictor variables and establish the cut-off score. Once the equation and cut-off score are determined, data from only the predictor variables would need to be collected for subsequent individuals. You would use their profile of scores to predict whether they are most like the gifted or non-gifted group. If their D score is above the cut-off, you predict them to be gifted.

The difficult question in the use of discriminant analysis to identify gifted students is where to set the cut-off score. Ideally the analysis would result in two distinct groups which do not overlap. In practice, this will never happen. The decision becomes one of which kind of error one wants to commit in classification. For example, given the figure above, we could set the cut-off score at D = -1.75. In this case, we would assure ourselves of including all gifted students in the predicted

gifted group, but we would also conclude that 50% of the non-gifted students are gifted. In contrast, we could set a cut-score of D = 1.50. In this case we do not include any non-gifted students in the gifted group. All students with D scores greater than 1.50 are in fact gifted. However, this cut-score misses 50% of the gifted students in the sample. Which type of error is worse? Do you want to screen into the predicted gifted group a larger number of non-gifted students in order to insure that you get most of the actual gifted students? Or do you want to assure yourself that the predicted gifted students are indeed gifted, even though you may not identify several gifted students. These are programmatic decisions to be made. The answers to the questions are dependent on philosophy, resources available, space and costs.

The remainder of this paper illustrates the application of discriminant analysis as an initial screening technique for gifted students in Project IMPAC. The process was cross-validated once and is currently undergoing cross-validation in another school district.

Project IMPAC Illustration

The purpose and use of indices in the screening process is to serve as a preliminary/early screening procedure to assist in the identification of potentially gifted students. The process is to be used to indicate a group of individuals who should be considered for more comprehensive testing at an early stage rather than to force exclusion of some group of pupils.

The needs of the project in identifying gifted students were both immediate and long-range. Gifted students in grades K-5 needed to be identified during the Spring, 1978, so that arrangements could be made for a sample to start the program in the Fall of 1978. The long-range need was

to develop an efficient, reliable and valid means of identification for use in subsequent years. The procedure outlined below attempted to provide for both of these needs.

The literature on the identification of gifted students leads to one conclusion: "No single procedure and/or instrumentation is available at present which is viewed as the way to identify gifted students." Rather, a multi-informational approach is generally used. Information is obtained from student records on group tests, parent ratings and interviews, teacher ratings and peer ratings all of which are then used under different models to select the gifted student. In addition the definition of "giftedness" is not consistent. One needs to specify whether it is general academic giftedness, giftedness specific to a content or skill area, or creatively gifted that is of interest. Once a definition is decided on, one could choose from an abundant number of available ratings forms, each slightly different from the others both in scaling and the characteristics to be rated. Due to the lack of consensus on definition, characteristics or instrumentation appropriate in the identification process, we proposed to start the development of an identification process from scratch with the hope that the information obtained would provide new insight and possibly a better procedure of identification. At the very worst, one would end up with a recommendation that an existing procedure be adopted.

The following procedure was intended to result in both the initial identification of students for including in the pilot program during the 1978-79 year of Project IMPAC and in data for one phase of the development and refinement of an identification process. The screening procedure focused on three pieces of primary information: (1) student standardized achievement test scores, (2) teacher ratings, and (3) student performance and response rates on a series of quickly administered, independent non-verbal tasks which objectively measure specific characteristics on the

teacher rating form. Other data such as parental recommendations supplemented these data as necessary. The first set of data, standardized achievement test scores, existed as part of the district testing program. Within the Garden City district, the SRA achievement battery is given in the Fall to grades 2-6 while the Metropolitan Readiness test is given to Grade 1 and the Boehm Test of Basic Concepts is given at the kindergarten level.

The construction of an initial teacher rating scale focused on the academically talented or gifted child in contrast to the creative child. In the construction of this scale, available instruments and literature were surveyed to identify different characteristics thought to be exhibited by gifted children. A list of 50 characteristics were identified. This list was then reviewed by two experts who direct gifted training programs at the university level. Based on their comments the list was revised and reduced to 32 characteristics. These 32 characteristics then formed the basis for the items on a rating scale to be used by teachers. One additional item was added plus some introductory comments to explain the intent of the instrument. The project staff then reviewed the instrument and judged it appropriate at this initial stage.

The teacher rating scale was refined and validated using two separate procedures. First, it was used as part of the identification process during the Spring 1978 semester in the Garden City School District to select the students who would participate in the IMPAC program in the Fall of 1978. The following data collection procedure using the teacher rating scale was implemented.

1. Existing standardized test scores were used to identify those students in the district with scores above the 90th percentile on the national norms. This identified a group of high achieving students at each grade level.

2. In addition to these students, two of the remaining students in each classroom whose standardized scores are not greater than the 90th percentile were selected at random. These students formed an additional comparison group used in identifying items on the teacher rating form which maximally discriminate among students with varied degrees of academic ability.

3. Each teacher used the scale to rate those children selected in #'s 1 and 2 above from his/her classroom. The teacher was given forms with each selected student's name on it from his/her class. In addition, each teacher was given blank rating forms so that they could identify and rate students who they felt exhibited gifted characteristics but who were not in the selected student groups.

4. Building principals were inserviced and then inserviced the teachers on the need, background, procedures etc. for filling out the rating form.

Once these data had been collected, individual intelligence tests (WISC) were given to students as the criterion measure of academic giftedness. The literature confirms this as the best criteria and at present, the only measure which is accepted as a valid indicator of academic giftedness. A criterion IQ score of 130 or higher is typically used as the definition of giftedness. For Project IMPAC, the operational definition was modified to include students whose IQ scores were within two standard errors of measurement of an IQ of 130 (IQ$\geq$125). From a measurement point of view, this is a more acceptable definition and increases the probability of including students whose true IQ scores are in the 130 or above range. This procedure provided for a criterion group of gifted and non-gifted

students. In total, 158 students were tested in Garden City and 31 in Scott City to identify the 64 gifted students who served as project or comparison group students.

The second procedure used to refine the items in the teacher rating instrument was an endeavor independent of the previous procedure. This process used expert judgements to validate the item characteristics as important contributors in differentiating between gifted and non-gifted students. An initial sample of approximately 200 teacher/experts in gifted education was mailed the rating form in Appendix B through the office of the National Association for Gifted Children (NAGC). Because a mailing list could not be obtained and the NAGC office required that they handle the mailing, no follow-up was possible. Usable responses were received from 85 experts.

The second set of measures which were adapted/developed were a series of grade appropriate non-verbal performance tasks. The use of this approach appears to be unique in the gifted literature. Two reoccurring themes in the literature lead up to propose the use of performance and response rate on a series of quickly administered tasks as indicators of giftedness. First, teacher's ratings have a tendency to be biased and have not been shown to be very beneficial in substantially contributing to the identification process. If this is true, it would be beneficial to have an objective measure of certain characteristics on the teacher rating form. Second, the words "quickly", "rapidly", "easily" etc. consistently appear in characteristics of the gifted which lead one to believe that gifted students not only perform at a high level on cognitive tasks, but they are able to do so at a more rapid rate than "regular" students. In addition, the use of non-verbal tasks which do not require a written response may be more appropriate for identifying gifted students from minority groups.

The tasks selected for the non-verbal performance battery were:

1. Raven's Progressive Matrices
2. Maze Tracing Speed Test
3. Identical Pictures Test
4. Addition/Subtraction Test
5. Story Sequence
6. Word Production
7. Number Comparison Test

The directions for each of these tasks emphasized speed of response. A set time limit was given for each and the child was instructed to do as many as possible within that time period. The Coloured Progressive Matrices was used as the first task. Tasks 2, 3, 4 and 7 were modified forms of tests from the ETS Kit of Reference tests for Cognitive Factors, and the Story Sequence task was a modification of the subscale from the Analysis of Learning Potential. The Word Production task was the only verbal task included, but had shown promise in previous studies. Two forms were developed, one appropriate for grades K-2 and the other for grades 3-6. Copies of each form are available in the IMPAC office.

Data for assessing the ability of the performance tasks to discriminate between gifted and non-gifted high achieving students were collected in both Garden City (30 students in grades K-2) and in the Blue Valley, Kansas school district (48 students in grade 3-5).

The procedure for obtaining expert ratings of gifted characteristics was described in an earlier section. Two ratings were required of each expert. First, they were to indicate the prevalence of each behavior separately for populations of gifted and non-gifted children in grades K-6. A ten point scale was used to code responses. Unfortunately, the example used in the directions caused some experts to respond inappropriately.

They assumed that the ratings for gifted and non-gifted populations had to add to 10 points, i.e., if they rated the prevalence of a behavior for gifted students as 7, they automatically gave a 3 to the non-gifted rating. However, this inappropriate response posed no problem in the consistency of ratings and results. The second rating required was to identify those characteristics which they would rank as the most important, second, third, fourth and fifth most important discriminator in differentiating gifted from non-gifted students in grades K-6. The directions and rating form are given in Appendix B.

In the data analysis of expert ratings, the average prevalence rating for gifted and non-gifted students was calculated for each of the 32 characteristics. The averages were obtained separately for those experts responding correctly to the directions (n=48) and those not responding correctly. Table 2 presents the mean ratings for gifted and non-gifted students based on the former group ratings (n=48). The direct discrepancy scores also were calculated as a measure of the discrimination ability of a given characteristic. To show the utility of the difference score, look at the data for items 6 and 7. The experts indicated that an average of 84% of gifted students exhibited the characteristic in item 7 (advanced vocabulary) while only 27% of regular students exhibited the characteristic. This should be a good item to use in discriminating the two groups. In contrast, the item 6 characteristic (is energetic) is prevalent in gifted populations (74%), but is also viewed as prevalent in non-gifted students (56%). Item 6 is not viewed then as a good discriminator by experts. The items in Table 2 are listed according to the size of their discrepancy scores. These data seem to be quite stable as indicated when these discrepancy ratings were correlated with the average ratings of those experts who did not follow directions correctly. The correlation coefficient for the 32 item ratings was .86.

The expert ranking data also is provided in Table 2. The number given for each item is the number of times that item was ranked as one of the top five discriminators. The top ten ranked characteristics are identified by an asterisk. All experts responded correctly to this portion and are included in the data reported in Table 2.

Table 2

Mean Expert Ratings of Prevalence of a Characteristic in Gifted and Non-Gifted Populations

Characteristic Item	Mean Prevalence Rating		Discrepancy Rating	Number of Times Ranked in Top 5
	Gifted	NonGifted		
7. Has unusually advanced vocabulary for age or grade level which s/he uses easily and accurately.	8.44	2.71	5.73	45*
9. Has rapid insight into cause-effect relationships.	7.92	2.52	5.40	28*
23. Readily deals with abstractions.	7.89	2.58	5.31	36*
8. Has quick mastery and recall of factual information.	8.02	3.15	4.87	17*
16. Generates a large number of ideas or solutions to problems and questions, often very quickly.	7.75	2.89	4.86	26*
30. Easily transfers learnings from one situation to another.	7.98	3.22	4.76	22*
27. Shows originality in responses.	7.80	3.09	4.72	22*
1. Is inquisitive; shows a great deal of intellectual curiosity.	8.44	3.83	4.61	42*
22. Grasps the relationship of individual steps to the whole process.	7.53	2.94	4.59	15*
24. Has the ability to concentrate intently on a topic for a long period of time.	7.66	3.09	4.57	20*

Table 2 (Cont.)

	Characteristic Item	Mean Prevalence Rating Gifted	Mean Prevalence Rating NonGifted	Discrepancy Rating	Number of Times Ranked in Top 5
2.	Retains what s/he has heard or read without much rote drill.	8.45	3.58	4.56	13
10.	Quickly makes valid generalizations about events, people, or things.	7.27	2.85	4.42	14
26.	Starts and pursues activities on his/her own initiative.	7.57	3.35	4.22	9
25.	Engages in many different projects and activities.	7.92	3.72	4.20	14
20.	Explains things precisely and clearly.	7.34	3.26	4.08	4
13.	Is a perfectionist and tends to be self critical of his/her own products.	6.85	2.85	4.00	12
3.	Is alert and keenly observant.	7.98	3.98	4.00	14
14.	Prefers to work independently.	7.33	3.45	3.88	4
5.	Experiments when necessary to get answers.	7.19	3.34	3.85	5
4.	Is flexible and open-minded in problem solving situations.	7.33	3.56	3.77	8
21.	Uses descriptive words to add color, emotion, and beauty.	7.15	3.42	3.73	1

Table 2 (Cont.)

	Characteristic Item	Mean Prevalence Rating Gifted	Mean Prevalence Rating NonGifted	Discrepancy Rating	Number of Times Ranked im Top 5
32.	Becomes impatient with himself/ herself and others if progress is not made toward task completion	7.42	3.70	3.72	9
15.	Likes to organize and bring structure to things, people, and situations.	7.08	3.42	3.66	3
18.	Is often critical.	7.36	3.74	3.62	5
19.	Exhibits self-confidence in learning situations and in interacting with other children and adults.	7.25	3.83	3.42	4
12.	Needs little external motivation to follow through in work that initially excites him/her.	7.29	3.79	3.40	14
28.	Is concerned with details.	6.96	3.60	3.36	5
11.	Is persistent in completing difficult tasks.	6.42	3.32	3.10	3
31.	Often is stubborn in his/her beliefs.	7.15	4.32	2.83	7
17.	Is a high risk taker.	6.19	3.45	2.74	5
29.	Is sensitive to the feelings of others.	6.70	4.70	2.00	4
6.	Is energetic.	7.44	5.65	1.79	3

The consistency in ratings and rankings is evident. The ten characteristics with the highest discrepanices in mean ratings also were the ten ranked in the top 5 most often. However, the correlation between the order within these 10 was not perfect. This is not surprising as you would expect the experts to use their ratings to rank order the characteristics. The major trend in the expert ratings is the importance placed on cognitive behaviors as predictors of giftedness. Those characteristics which tend to be personality oriented are ranked at the bottom in terms of their importance as discriminators between gifted and non-gifted populations.

The data from the teacher ratings of gifted and non-gifted students were factor analyzed to see if any clusters of characteristics were being rated the same. Teacher ratings for high achieving students (gifted and non-gifted students with achievement composites greater than 90th percentile) were analyzed using an initial truncated principle components solution with subsequent orthogonal rotation using the varimax solution. Several criteria were used to determine the number of factors to rotate. The eigenvalue greater than 1.00, the screen test, the successive rotation of different numbers of factors were used until the best solution was found in terms of interpretation. There were six factors with eigenvalues greater than 1.00 in the initial solution, the screen test indicated five factors, so seven, six, five, four, and three factors were rotated. The four factor solution gave the best result in terms of simple structure and interpretability. The four factors identified were creativity, diligence, higher level cognition, and criticism of self and others. Table 3 lists those items which loaded on each factor and the factor loadings. The items which crossloaded or did not load at all are given also. The ratings for 195

students were included. The same analysis also was completed which included the random sample of students rated by each teacher. The analysis which was on 306 ratings gave the same results as those for the 195 high achievers.

Table 3

Factors and Factor Loadings for Items
Based on Teacher Ratings

Factor 1: Creative Behaviors	Factor Loading
1. Is inquisitive; shows a great deal of intellectual curiosity.	.674
3. Is alert and keenly observant.	.577
4. Is flexible and open-minded in problem solving situations.	.593
5. Experiments when necessary to get answers.	.552
6. Is energetic.	.690
16. Generates a large number of ideas or solutions to problems and questions, often very quickly.	.568
19. Exhibits self-confidence in learning situations and in interacting with other children and adults.	.610
Factor 2: Diligent Behaviors	**Factor Loading**
11. Is persistent in completing difficult tasks.	.774
13. Is a perfectionist and tends to be self critical of his/her own products.	.601
14. Prefers to work independently.	.517
24. Has the ability to concentrate intently on a topic for a long period of time.	.721
28. Is concerned with details.	.641

Factor 3: Higher Level Cognitive Behaviors	Factor Loading
2. Retains what s/he has heard or read without much rote drill.	.597
7. Has unusually advanced vocabulary for age or grade level which s/he uses easily and accurately.	.587
8. Has quick mastery and recall of factual information.	.719
9. Has rapid insight into cause-effect relationships.	.785
10. Quickly makes valid generalizations about events, people, or things.	.717
20. Explains things precisely and clearly.	.620
22. Grasps the relationship of individual steps to the whole process.	.764
23. Readily deals with abstractions.	.712
27. Shows originality in responses.	.577
30. Easily transfers learnings from one situation to another.	.671

Factor 4: Criticism Behaviors	Factor Loading
18. Is often critical.	.802
31. Often is stubborn in his/her beliefs.	.793
32. Becomes impatient with himself/herself and others if progress is not made toward task completion.	.666

Other items not loading or not clearly defined.

12. Needs little external motivation to follow through in work that initially excites him/her.

17. Is a high risk taker. (Academically gifted)

15. Likes to organize and bring structure to things, people, and situations.

21. Uses descriptive words to add color, emotion, and beauty.

25. Engages in many different projects and activites.

26. Starts and pursues activities on his/her own initiative.

29. Is sensitive to the feelings of others.

Along with teacher ratings, non-verbal performance tasks were used as part of the identification procedure. To see if teacher ratings, non-verbal performance, and/or a combination of both were able to differentiate gifted students from non-gifted high achievers, a series of discriminant analyses were performed. The number of students in each group varied across analyses dependent on which students had complete data sets on the variables under study. The criterion used to classify students into gifted and non-gifted groups for the discriminant analysis was an IQ of 125.

The use of the teacher ratings as predictors of gifted versus non-gifted classification was generally non-productive. The only item which significantly differentiated groups was item 33 which asked teachers to categorize the student as,

a. academically gifted (capacity for superior mental functioning).

b. a high achiever with high ability, but not academically gifted.

c. a high achiever with average to above average ability, but one who works extremely hard.

d. none of the above.

The individual items or composite subscales formed from the factor analysis did not add to the discrimination ratings of teachers. While the discriminate function was statistically significant, it only classified 72% of the gifted students correctly and 67% of the non-gifted students.

The data analysis using scores from the non-verbal performance tasks was more encouraging. For each of the seven tasks, means and standard deviations were obtained for combined gifted and non-gifted students at a grade level. These grade level indices were then used to transform each student's raw score to a standardized z-score for their grade level. Grade levels were then combined in the analysis using grade appropriate z-scores as the predictor variables in a discriminant analysis. Both the number right and number wrong were used as response variables for all tasks except the Identical Pictures task, Word Production and the Numbers Comparison task.

The number of students on which non-verbal performance data existed and who were classified as gifted and non-gifted, respectively, by grade level were as follows:

Grade	Gifted	Non-Gifted
K	5	11
1	2	9
2	4	14
3	9	9
4	10	9
5	7	3
Total	37	55

The discriminant function for these data were statistically significant ($p < .05$). The standardized discriminant function weights were:

Variable	Standardized Discriminant Weights
Raven (# Right)	.083
Raven (# Wrong)	-.152
Maze (# Right)	.541
Maze (# Wrong)	-.065

Variable (Cont.)	Standardized Discriminant Weights (Cont.)
Picture	.224
Addition (# Right)	.393
Addition (# Wrong)	-.133
Story Seq. (# Right)	.189
Story Seq. (# Wrong)	-.250
Word Prod.	-.075
Comparison	-.475

As for the classification power of these variables, 84% (31 of 37 students) of the gifted students were correctly identifeid and 73% of the non-gifted students were correctly classified. This classification ratio in terms of hits and misses is in the desired direction with few gifted students being missed. The pattern of weights is interesting. The Maze task and the Number Comparison task received the highest weights. The change in sign for these two weights reflects the fact that gifted students performed better on the Maze task while the opposite was true for the Numbers Comparison task. The only tasks which did not appear to be useful was the Raven's and Word Production.

When both teacher ratings and the non-verbal tasks were used as predictors of giftedness, 37 gifted and 31 non-gifted students had complete data sets. For these students, teacher ratings did contribute to the prediction. Those variables which has statistically significant univariate F-ratios were item 25, item 26, diligence subscale, cognition subscale, criticism, subscale, maze right, addition right, addition wrong, story sequence right, story sequence wrong, and the numbers comparison task. The discriminant function derived through weighting the predictor variables was statistically significant ($p < .05$). The standardized discriminant function weights primarily identified the above variables as important

contributors to the discrimination. The classification power was improved. When the computer programs standard classification criterion was used 89% of the gifted students and 84% of the non-gifted students were correctly classified. Using this function, four of the gifted students would have been identified as non-gifted and five of the non-gifted as gifted.

However, the present project's primary aim is to minimize the number of gifted students missed in the screening process while still reducing the number of students to be individually tested. When looking at the distribution of discriminant analysis scores, it appears that a cut-off score of -.5 would serve the project best. Using scores above -.5 as predictive of a gifted classification, the correct classification of gifted students can be raised to 95% accuracy (2 of 37 gifted students would be missed).

It should be noted that the increase in correct identification of gifted students is accompanied by a drop in the correct identification of non-gifted students to 71%. This trade-off would seem to be worth the extra testing needed to identify two more gifted students.

Cross-Validation Results. To establish the stability of the classification process using the weights assigned to each variable by the discriminant analysis, the complete identification procedure was replicated at Hugoton, Kansas. First students were selected based on their standardized achievement test scores (percentile ranks greater than 90). Teachers were then asked to rate these students using the IMPAC Teacher Rating Form. They also were to nominate and rate any other student in their class who they thought were gifted, but not included in the high achievement group. All students rated by a teacher then were administered the set of non-verbal performance tasks. Finally, to establish whether a student was actually gifted or not as defined by Project IMPAC, the WISC-R was individually administered to each child. Data on a total of 58 students were collected.

With the data resulting from this procedure, all necessary information was available to cross-validate the original discriminant analysis classifications. The following procedure was used in the cross-validation.

1. Scores for each student on each Teacher Rating subscale was obtained by summing scores across the items for that subscale.

2. Scores on each non-verbal performance task were transformed to z-scores using the grade group means and standard deviations from the original Garden City and Blue Valley samples.

3. The Teacher Rating subscale scores and non-verbal performance task z-scores for each student were converted to discriminant scores using the weights from the Garden City/Blue Valley sample.

4. The discriminant score for each student was used to classify the student as <u>potentially</u> gifted or non-gifted. A discriminant score of -.5 was used as the cut-off score. All students with scores above -.5 were predicted to be gifted. Those below were predicted to be in the non-gifted group. This criterion was used based on the original analysis. It appeared that this cut-off score minimized the number of gifted students missed in the identification process while still correctly excluding a sizable number of non-gifted students from individual IQ testing.

5. The predicted classification of students were compared against their actual classification based on the WISC-R scores.

Based on this procedure, the following classifications resulted.

		Predicted Classification		
		Non-Gifted	Gifted	
Actual Classification (IQ 125)	Non-Gifted	13 (34%)	25 (66%)	38
	Gifted	2 (10%)	18 (90%)	20

As can be seen in the table, 18 of the 20 gifted students were correctly predicted to be gifted. Two gifted students would have been missed by the procedure. In addition, 13 or 34% of the non-gifted students would have been correctly excluded from further testing. In summary, of the

58 students in the original pool, one would only need to administer the WISC-R to 43 or 74%. This is a 26% reduction in individual testing time while still having 90% accuracy in the identification of gifted students.

While these results are reasonably impressive, there is substantial room for improvement. Ideally, the best identification procedure would reduce the number of non-gifted students who are predicted as gifted while also reducing the number of gifted students who are incorrectly predicted as non-gifted. Using -.5 as a cut-off score, this latter group in each analysis is minimal (5% in the original analysis and 10% in the cross-validation). Both these figures should be improved as the IMPAC identification procedures are refined.

Recommendations. The following procedures are recommended for the screening/identification of gifted students within the Project IMPAC area. These procedures are continually undergoing refinement and will be modified as additional data are collected from school systems wishing to participate in the Project IMPAC gifted program.

1. Standardized achievement test scores should be used as an initial selection measure (percentile ranks of 90 or above on achievement composite).

2. Awareness information should be distributed to parents so that they can nominate students.

3. Teachers should be allowed to nominate students at the time of teacher rating.

4. Teachers should rate all students nominated in steps 1, 2, or 3 on the IMPAC Teacher Rating scale. It is suggested that items on the creativity subscale and items 12, 15, 17, 21, and 20 be dropped from the rating scale. These items did not appear to help in discriminating between groups.

5. All students rated by teachers also should be given the set of non-verbal performance tasks. It is suggested that the Picture Comparison and Word Production tasks be dropped from the battery. Also, the use of the Raven's Progressive Matrices needs to be revised or dropped. Because it is an acceptable non-verbal measure of IQ, I would suggest that

we lengthen the time of administration (5 minutes?) and see if it might help discriminate gifted from non-gifted students.

6. Subscale scores and scores for items 25 and 26 should be obtained for each child on the Teacher Rating scale.

7. Scores on the non-verbal tasks should be obtained and converted to standard scores (z-scores) using the group means and standard deviations from Garden City, Blue Valley, and Hugoton as a baseline. These group means and standard deviations should be up-dated each time a new group of students is tested.

8. The scores from the scales identified in steps 6 and 7 should be entered in the discriminant equation to get a discriminant score for each student. This equation should be refined with at least one more set of data from an entire school district. Once a stable equation is determined (hopefully by the fall of 1980), a simplified form can be presented for use by district personnel.

9. All students with discriminant scores above -.5 should be given an individually administered IQ measure (WISC-R).

10. If a student has a WISC-R IQ greater than 125, they qualify for the gifted program.

11. All students in the original screening group should be monitored after assignment to a program. Flexibility should be maintained in the retesting of students and movement of students in and out of the program if needed. While the screening procedure above will work for a large majority of students, one needs to be sensitive to individual cases which may not follow set guidelines.

At present, the application of the above procedure is dependent upon the knowledge of discriminant analysis and the use of the computer. Both these dependencies are non-functional for school personnel. It is the goal that the procedures and equations used for classification can be reduced to functional use by the end of the 1980-81 project year. The development of a sophisticated procedure which has no functional use by project personnel is not a desirable outcome.

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